Wind-Turbulence-Wave Interactions

Carl A. Friehe
Departments of Mechanical Engineering and Earth System Science
University of California, Irvine
Irvine, CA 92697-3975
Phone (949) 824-6259 Fax (949) 824-2249 email: cfriehe@uci.edu

Award #: N000149610061
http://wave.eng.uci.edu

LONG-TERM GOALS

The long-terms goals of the research are to understand and parameterize the physics of air –sea interaction, and in particular wind-wave interaction. The effort is primarily experimental, based on measurements over the sea under a variety of wind-wave conditions. Applications are to EO propagation and scintillation over the ocean.

OBJECTIVES

The objective is to develop similarity parameterizations of air-sea interaction and the MABL. Underlying this is the improvement of the basic understanding of wind-wave physics.

APPROACH

The approach is in-depth analysis of the wind, turbulence and wave data obtained in the Marine Boundary Layers ARI experiment from R/P *FLIP*. Approximately 7 GB of data were obtained. Spectral, statistical and other analyses are applied to the data to determine the physics of wind-wave interaction and parameterizations of air-sea interaction. Theoretical analyses of atmospheric turbulence are undertaken.

WORK COMPLETED

Work has focussed on the interpretation of the wind, wave and wind stress results obtained from the MBL data set. A theoretical analysis of surface fluxes was undertaken to determine the corrections necessary when there are finite mass and heat fluxes at the surface. The work cleared up previous misunderstandings.

RESULTS

The surface layer turbulence structure over wind waves and swell is found to be different from that over land. The common assumption for the surface layer is that there is negligible stress divergence. The depth of the constant stress layer should increase with increasing wind speed. The MBL results however show the opposite (See Figure 1). This is due to the wind waves and swell growing with the wind. As shown in Figure 1, the stress divergence tracks the wave height time series almost exactly. Another interesting feature shown in Figure 1 is that the stress itself extrapolated to the surface leads

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **SEP 2000**	2. REPORT TYPE	3. DATES COVERED **00-00-2000 to 00-00-2000**

4. TITLE AND SUBTITLE **Wind-Turbulence-Wave Interactions**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Departments of Mechanical Engineering and Earth System Science,,University of California, Irvine,Irvine,,CA,92697**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**4**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

the wave signal. This is probably due to the fact of increased momentum transfer to the waves when the waves are growing.

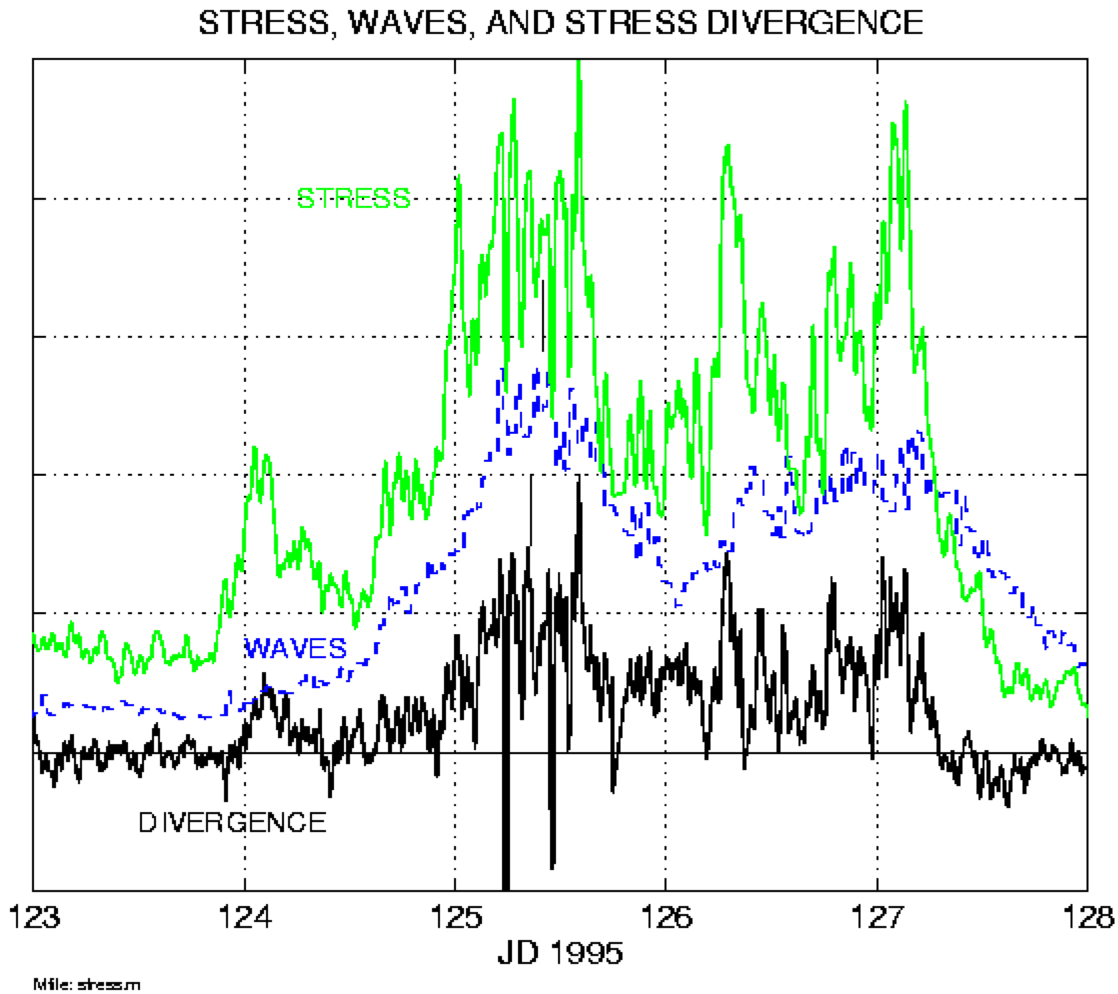

Figure 1: Time series of wave height, wind stress and stress divergence from the MBL experiment on R/P FLIP.

The corrections to surface sensible heat, latent heat, momentum and trace gas species fluxes were derived. For the first time, corrections to the momentum flux were obtained.

IMPACT/APPLICATIONS

The impacts of the research will be in the improvement of the basic understanding of air-sea interaction processes in particular the physics of wind-wave coupling. The research will lead to better parameterizations of air-sea interaction, such as the wind stress, through incorporation of wave effects.

The result of significant stress divergence in the lower 20 m above the waves in high winds should have impacts on wave forecasting models and large-scale weather models.

The corrections to surface fluxes will be of use for past and future eddy correlation flux measurements.

TRANSITIONS

We are working with the Navy Space and Warfare Systems Command, SPAWAR about measurements and wave effects on radar and optical propagation in the surface layer over the ocean. We are preparing for an experiment, Rough Evaporation Duct, to be conducted on the Research Platform *FLIP* in fall 2001.

RELATED PROJECTS

This project is related to our participation in the SPAWAR Red experiment.

PUBLICATIONS

Journal Papers:

J. Overland and C. A. Friehe, "Coastal Meteorology," Coastal Ocean Prediction, Coastal and Estuarine Series, C. N. K. Mooers, ed., Vol. 56, American Geophysical Union, Washington, D.C., pp. 7-29, (1998).

Khelif, D., S. P. Burns and C. A. Friehe, "Improved Wind Measurements on Research Aircraft," J. Atmos. and Ocean. Tech., 16, pp. 860-875 (1999).

Burns, S. P., D. Khelif, C. A. Friehe, ..., "Comparisons of Aircraft, Ship and Buoy Meteorological Measurements from TOGA COARE," J. Geophys. Res. (Atmospheres), 104, no. D24, pp. 30853-30883 (1999).

Fuehrer, P. L., C. A. Friehe, T. S. Hristov, D. I. Cooper and W. E. Eichinger, "Statistical-Uncertainty-Based Adaptive Filtering of Lidar Signals," Appl. Optics, 39, no. 5, pp. 850-859 (2000).

Burns, S. P., D. Khelif, C. A. Friehe, ..., "Comparisons of Aircraft, Ship and Buoy Radiation and SST Measurements from TOGA COARE," J. Geophys. Res. (Atmospheres), 105, no. D12, pp. 15627-15652 (2000).

Presentations:

"Wind and Turbulence over Waves," Department of Meteorology, Uppsala University, Uppsala Sweden, October 1999.